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C-A OPERATIONS PROCEDURES MANUAL

18.7.1 ERL Cold Emission Test Cryogenic System Operation

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Hand Processed Changes

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Approved: _____ ***Signature on File*** _____
 Collider-Accelerator Department Chairman Date

D. Lederle

18.7.1 ERL Cold Emission Test Cryogenic System Operation

1. Purpose

This procedure covers the basic operation of the ERL Cryogenic System for the Cold Emission Test.

The cryogenic systems for Cold Emission Test consist of supplying liquid helium and liquid nitrogen to the 5 cell ecX cavity cryomodule. Liquid helium is supplied from two portable dewars to the cryomodule. Liquid nitrogen is supplied from the 300 gallon portable buggy.

The first dewar is a low pressure 500 Liter dewar from the gas distributor, that will be used to supply liquid helium to the cryomodule/ballast tank. This dewar supplies helium to cooldown the cavity and ballast tank and to fill the ballast tank.

A 250 Liter high pressure dewar will be used to supply liquid helium to the 5K heat stations and Fundamental Power Coupler (FPC).

Liquid Nitrogen is supplied via insulated lines to the cryomodule and ballast tank for the 80K thermal shield.

2. Responsibilities

- 2.1 A shift supervisor, or an operator designated by the shift supervisor, is responsible for implementing the procedure.

3. Prerequisites

- 3.1 Vacuum pump skid available ([C-A-OPM 18.7.2](#)).
- 3.2 Operator shall become familiar with the system P&ID drawing 010604017, the control system screen(s) on the operator station, and the physical location of components.
- 3.3 ESH
- 3.3.1 The following PPE is required to handle the connection of portable liquid helium dewar to the cryomodule:
- Face Shield
 - CryoGloves
 - Long sleeve shirt

- 3.3.2 While work is underway and an abnormal condition arises, re-review the job against criteria in applicable SBMS Subject Areas, and/or work planning requirements. If unsure of further actions, discuss situation with supervisor.

4. Precautions

When the 250 Liter dewar is rolled into the block house the ODH system must be functional.

5. Preparation and System Component Checkout

5.1 *Instrument Air*

Verify that instrument air is available to the air supply line to the air actuated control valves.

5.2 *Valve check-out*

Verify operability of all automatic valves from the ERL control screens:

5.3 *Instruments*

Verify all ERL pressure, temperature, and diff. Press. instruments have indication on the ERL control screens.

5.4 *Liquid Helium Inventory and Delivery*

Send out the two 3-atm portable dewars to the liquid helium vendor for fill. Check to ensure that the 3 atm dewar is identified with a BNL property tag and label prior to sending it for pickup and refill by liquid helium distributor.

Order additional low pressure dewars, Qty 3, 500-Liter liquid helium dewars for delivery on the day before use.

5.5 *Liquid Nitrogen Inventory and Delivery*

Fill 300 Gallon LN2 Buggy, and park near bldg 912 North West door.

5.6 *Initial Dry Out and Purging Process (Initial commissioning)*

Connect flex line from buggy to vaporizer and connect hose from vaporizer to the 3" helium return header located on the outside of the west shield wall.

Establish warm N2 purge flow from the 3" header, through the cavity, ballast tank, 10" return line, vaporizer, and vent to atmosphere:

- Close H10947M, H10919A, H10912M, H10944A
- Isolate return lines from power coupler, end flanges and tuner
- Open H10956A, H10918A, H10922A, H10896A, H10974A, H10982M
- Open vent path to atmosphere downstream of H10982M

Connect a portable dewpoint meter near vent outlet. Purge until dewpoint is –60C or better. At some point during the purge process, perform the following:

- Establish temporary purge backwards through the end flange, power coupler and tuner cooling circuits and vent to atmosphere through H10926M with the dewar disconnected.
- Temporarily open H10912M with the dewar disconnected and vent to atmosphere.
- Temporarily flow through H10919A.

5.7 *Evacuate and Purge*

Connect portable roughing pump to H10971M and pump entire system, with all process valves open, down to less than 50 Microns. Backfill to slightly over 1 atm with warm helium gas. Perform this three times.

5.8 *Insulating Vacuum*

Verify with vacuum group that cryomodule insulating vacuum has been established and has been maintained for preferably one week prior to cooldown.

5.9 *Beam Tube vacuum*

Verify with vacuum group that beam tube vacuum is in the UHV range prior to cooldown.

6. Procedures

6.1 *Connect 500 Liter Low pressure Dewar*

- Verify positive pressure up to H10912M.
- Shut H10956A, H10919A, and H10918A.
- Don required PPE: cryo gloves, face shield, POM, long sleeve shirt
- Open valve H10911M on the stinger assembly
- Open the ball valve on the liquid draw line on the helium dewar.
- Insert the stinger end into the dewar.
- Remove caps on the bayonets and insert the male bayonet into the mating bayonet on the dewar section.
- Crack open H10912M, allowing a small helium flow to come out of the valve.
- Complete the bayonet connection.
- Open H10912M completely

6.2 *Connect 250 Liter 3 atm Dewar*

- Verify positive pressure up to H10926M.
- Verify end flanges, power coupler, and tuner flow controllers are in manual at 0 g/s, and that the manual inlet and outlet isolation valves are open.
- Don required PPE: cryo gloves, face shield, POM, long sleeve shirt.
- Open valve H10925M on the stinger assembly.

- Open the ball valve on the liquid draw line on the helium dewar.
- Insert the stinger end into the dewar.
- Remove caps on the bayonets and insert the male bayonet into the mating bayonet on the dewar section.
- Crack open H10926M, allowing a small helium flow to come out of the valve.
- Complete the bayonet connection.
- Open H10926M completely.
- The dewar can now be pressurized to the required pressure of 3 atm (30 psig).

6.3 *Establish LN2 Heat Shield Flows*

- Connect LN2 Buggy to LN2 supply line.
- Verify N2700M and N6230M are shut.
- Open ballast tank and cavity common heat shield outlet valve N6232M.
- Throttle open N6226M to establish ballast tank heat shield flow.
- Throttle open N6225M to establish cavity heat shield flow.
- Adjust N6225M and N6226M as necessary to achieve 80 to 90K outlet temperatures.

6.4 *Cooldown: Room temperature to 4.4K*

6.4.1 500 Liter Dewar Supply

- Shut H10975A, H10944A, and H10947M (3" manifold outlet).
- Open H10982M by vacuum pump skid
- Establish vent path to atmosphere downstream of H10982M
- Open cryomodule vent valve H10922A (larger of the two vent valves)
- Commence cooldown flow by simultaneously opening H10975A and throttling open H10918A (cryomodule bottom feed).
- Adjust pressure building regulator on the helium gas supply line into the low pressure dewar to 2 psig.
- Monitor cavity and ballast tank pressure and temperature indication, and flow out of the vent path to atmosphere.

6.4.2 250 Liter 3 atm. Supply

When cavity temperatures approach 80K, commence flow from 3 atm. Dewar:

- Verify vent path to atmosphere downstream of H10947M
- Open H10947M
- Establish flow through tuner, end flanges, and power coupler by setting flow controllers to desired setpoints.
- Monitor end flanges, tuner, and power coupler temperatures.

6.5 *Filling and Heat Leak Test at 4.4K*

- Continue cooldown until level is established in the ballast tank, then close H10918A.
- Realign vent path to atmosphere so that it passes through FT4010H or FT4009H.

- Record level, pressure and flow indications for 30 minutes.
- Reestablish ballast tank level prior to 2k pumpdown

6.6 *Pumpdown to 2K and 2K Operation*

- Start vacuum pump in manual mode as described in OPM 18.7.2 sect. 5.1.
- Check closed H10918A, H10919A, H10956H.
- Quickly perform the following: Close H10922A, H10896A, H10975A, then crack open 10" vacuum pump suction valve H10944A. (Booster should still be off at this point as per 18.7.2)
- Monitor cryomodule pressure and vent if necessary.
- Slowly open H10944A to full open, being careful not to overload Kinney pumps.
- Crack open H10922A and continue pump down with Kinney pumps only until vacuum pump suction pressure drops below 35 torr, then place booster in auto as per 18.7.2.
- Use H10922A or H10896A to control 23 torr at the vacuum pump suction, PT-1.
- When cavity is at 2K, switch pressure control to vacuum skid bypass valve V-3 and slowly open H10922A and H10892A fully.

6.7 *5 Cell Cavity Warm-up*

- Shut off the LN2 supply to the heatshields.
- Shut off the 3 atm. helium supply to the end flanges, power coupler and tuner. Line up return path to atmosphere or compressor suction.
- Shut down vacuum pump skid and align cavity/ballast tank vent path to atmosphere or compressor suction.

7. Documentation

7.1 Record

The check off lines in the procedure are for place keeping only. The procedure is not to be initialed or signed, it is not a record.

7.2 Log

The shift supervisor shall document the completion of the procedure in the cryogenics control room log book.

8. References

- 8.1 [C-A-OPM 18.7.2, "ERL OPM Process Vacuum Pump".](#)
- 8.2 Drawing: 010604046: eCX 5 Cell Cavity Cryo Module
- 8.3 Drawings: 010604017, 010604015

9. Attachments

9.1 Valve Description/Location Table

Valve Description/Location Table

Tag	Description	Location
H10896A	1 inch Ballast tank vapor return control valve	Ballast tank
H10909M	Low Pressure 500 Liter Portable dewar vessel relief	
H10910R	Thermal relief, isolated bayonet connection	
H10911M	Isolation valve between helium supply bayonet and Low Pressure 500 Liter Portable dewar	500 liter dewar
H10912M	Isolation valve Male side of bayonet stab	500 liter dewar
H10913R	Thermal relief, trapped volume between valve H10912M and cryo-module helium supply valves	
H10918A	Cavity helium cooldown supply control valve	Ballast tank
H10919A	Ballast tank Liquid helium fill valve	Ballast tank
H10922A	2 inch Ballast tank vapor return control valve	Ballast tank
H10923R	3 atm 250 Liter Portable dewar vessel relief	
H10924R	3 atm Dewar, Thermal relief, isolated bayonet connection	
H10925M	Isolation valve between helium supply bayonet and 3 atm dewar	250 liter dewar
H10926M	Isolation valve Male side of bayonet stab, 3 atm dewar	250 liter dewar
H10927R	Fundamental Power Coupler heat station line thermal relief	
H10928M	Fundamental Power Coupler heat station line return isolation valve	Outside west shield wall
H10930M	Fundamental Power Coupler heat station line Flowmeter outlet isolation valve	Outside west shield wall
H10931R	Thermal transition heat station #1 (End Flange) line thermal relief	
H10932M	Thermal transition heat station#1 (End Flange) line Flowmeter outlet isolation valve	Outside west shield wall
H10934	Thermal transition heat station#1 (End Flange)	Outside west

	line return isolation valve	shield wall
H10935R	Thermal transition heat station #2 (End Flange) line thermal relief	
H10936M	Thermal transition heat station#2 (End Flange) line return isolation valve	Outside west shield wall
H10938	Thermal transition heat station#2 (End Flange) line Flowmeter outlet isolation valve	Outside west shield wall
H10939R	Lead flow Flowmeters return manifold thermal relief	
H10940R	Process relief Ballast Tank	
H10944	10" butterfly inlet control valve process vacuum skid	Vacuum skid
H10947M	3" manifold isolation	Outside west shield wall
H10956A	Helium supply Pre-cool control valve	Ballast tank
H10961R	Thermal relief, trapped volume from valve H10926M and cryo-module 3 atm helium supply line.	
H10968M	Discharge flowmeter selection valve	By vacuum skid
H10969M	Test bypass loop	By vacuum skid
H10970M	Vacuum pump suction vent	By vacuum skid
H10971M	Vacuum pump discharge vent	By vacuum skid
H10972M	Test bypass loop	By vacuum skid
H10973M	3" flow meter outlet to compressor suction	By vacuum skid
H10975A	Vacuum skid bypass	By vacuum skid
H10982M	Vacuum skid bypass	By vacuum skid
H10984M	Test bypass loop	By vacuum skid